Non-Line of Sight Cannon

Precision Strike Annual Review

21 April 2004

Major Darby McNulty

NLOS Cannon Agenda

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

- NLOS Development Team
- FCS/UA Increment 1
- NLOS Cannon - Family of Vehicles (FoV) & System of Systems (SoS)
- Commonality Across FoV
- FCS Requirements Flow (From System to Platform)
- NLOS Cannon CTD Efforts & Accomplishments
- SDD Efforts – NLOS Cannon Specs and Design Drivers
- SDD Trade Studies and Analyses (MGV & NLOS Cannon)
- Gun Caliber Efforts (155mm versus 105mm)
- Path Forward – MGV SRR and SFR Efforts
  - SRR Efforts – 17 Criterion
  - PIDs (Prime Item Development Specifications)
  - BTA (Best Technical Approach)

United Defense – NLOS Vehicle Integrator

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

Vehicle Integrator Contributions

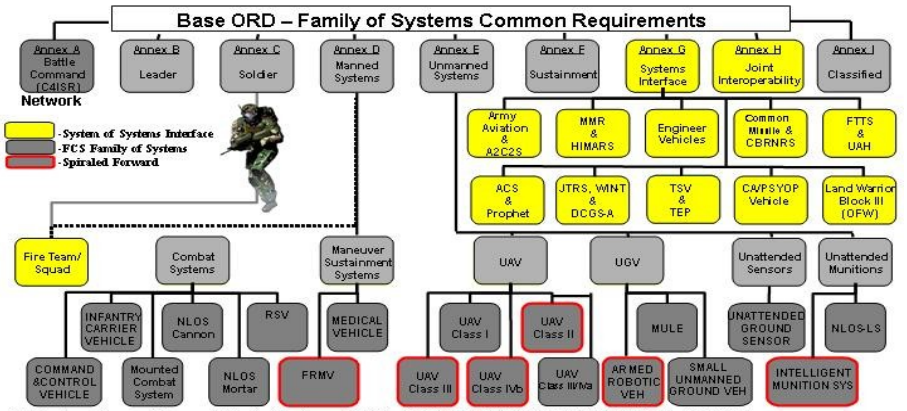
- NLOS-C Mission Module Unique Subsystems
  - Structure – UDLP
  - Active Protection – UDLP
  - Signature Reduction – UDLP
  - Mission Equipment – UDLP
  - Electronics – UDLP
  - Armor – UDLP
  - Resupply – UDLP
  - Other… – UDLP
- MGV Common Subsystems
  - NBC / ECS – GDLS
  - Structure/Armor – UDLP/GDLS
  - Crew Stations – UDLP
  - Propulsion – UDLP
  - Suspension – GDLS
  - Vetronics – GDLS
  - Signature Reduction/Def Arm't – UDLP
  - Common Integration – UDLP/GDLS
  - Other… GDLS / UDLP

Other Contractor Contributions

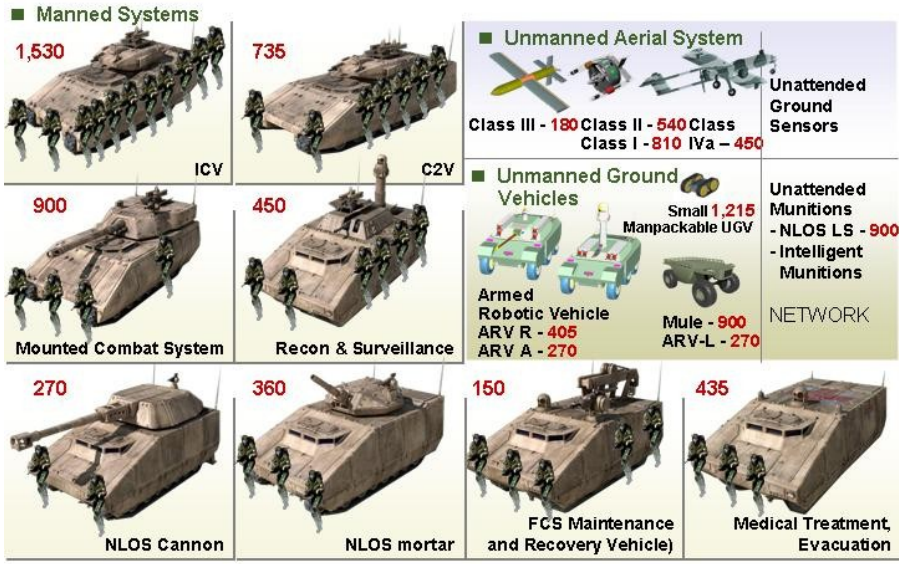
- Supportability
  - Logistics – Northrop Grumman
  - Decision Support Systems – Northrop Grumman
  - Platform Soldier Mission Readiness – Honeywell
  - Integrated Computer – GDLS
- Training
  - Training Support Package – Dynamics Research Corp / Computer Science Corp / Northrop Grumman
  - Planning and Preparation - GDLS
  - Situation Understanding – Austin Information Systems
  - Ground Platform Communication – BAE Systems
- C4ISR
  - Ground Sensor Integrator -- Raytheon
  - ISR Sensor – Lockheed Martin / Oricon Defense / GDLS
  - Fusion / Sensor Data Mgmt – Lockheed Martin / Oricon Defense / GDLS
  - Battle Mgmt & Mission Execution – Raytheon
  - Warfighter Machine Interface – Boeing
- System of Systems Engineering – Boeing/SAIC
  - SOSCOE Boeing
    - Operational/Architectural development & functional allocation of Eng requirements
    - Process Control and Program Management

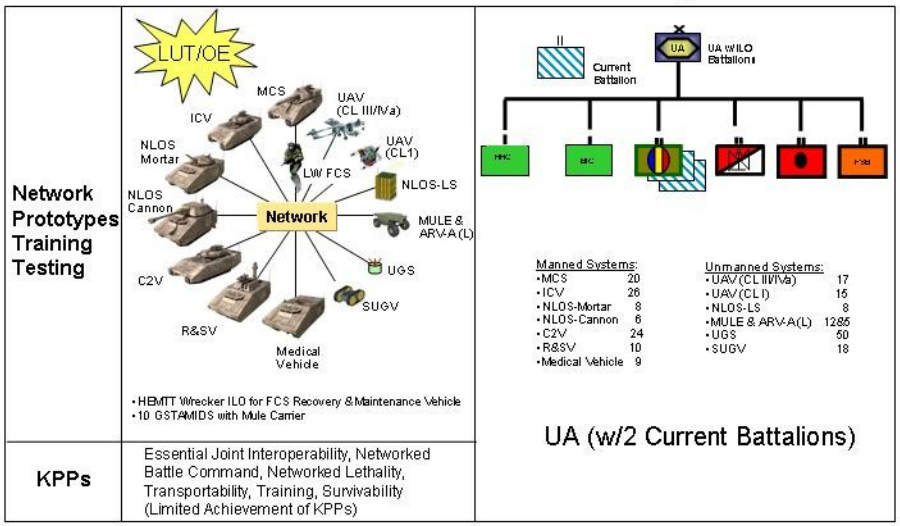
FCS Increment 1

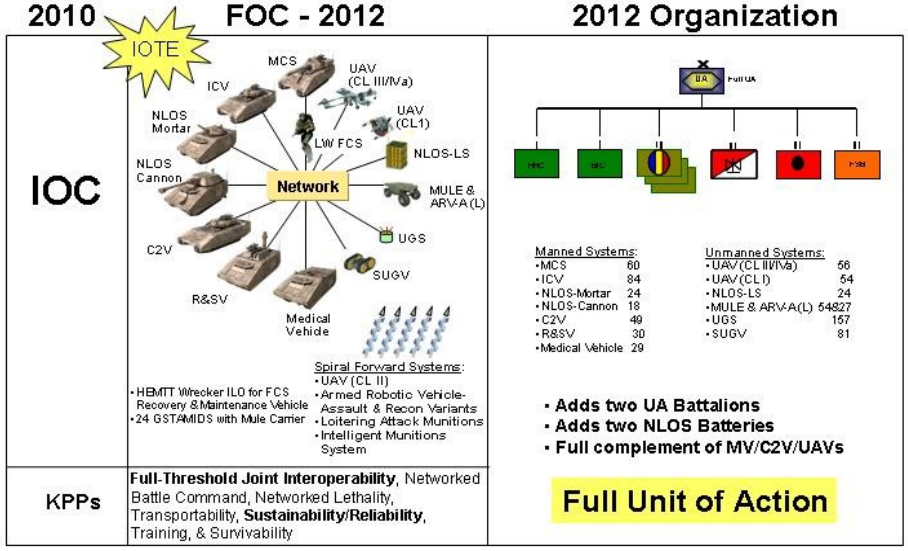
FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry



A2C2S – Army Airspace Command & Control System
ACS – Aerial Common Sensor
ARV – Armed Robotic Vehicle
C2V – Command and Control Vehicle
CA/PSYOP – Civil Affairs and PSYOP Vehicle
CBRNRS – CBRN Reconnaissance System
DCGS-A – Distributed Common Ground System – Army
FRMV – FCS Recovery and Maintenance Vehicle
FTTS – Family of Tactical Truck Systems
HIMARS – High Mobility Artillery Rocket System
ICV – Infantry Carrier Vehicle
IMS – Intelligent Munitions System
JTRS – Joint Tactical Radio System
LOS – Line of Sight
MCS – Mounted Combat System
MMR – Multi-Mission Radar
MULE – Multi-function Utility/Log Equip. Veh.
MV – Medical Vehicle
NLOS – C – Non-Line of Sight - Cannon
NLOS – M – Mortar
NLOS – LS – Launch System
RSV – Reconnaissance and Surveillance Veh
SUGV – Small Unmanned Ground Vehicle
TEP – Tactical Electrical Power
TSV – Theater Support Vessel
UAH – Up Armored HMMWV
UAV – Unmanned Aerial Vehicle
UGS – Unattended Ground Sensors
UGV – Unmanned Ground Vehicles





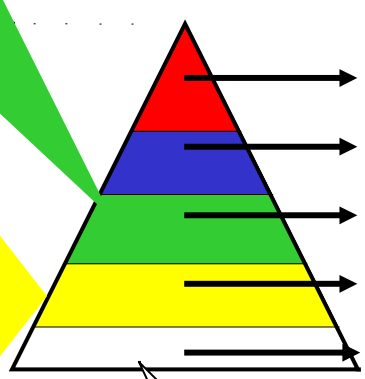


NLOS-Cannon Requirements

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

- Receive Joint Fire Missions
- Compute Own Firing Solution

- Verify Ammunition
- Auto load/fire current/future munitions
- Direct Fire Capability
- Manual Download Capability
- Rearm Times
- Information Exchanges
- Ammunition Payload
- Emplaced Response Time
- Outside Traverse Limits
- Moving Response Time
- Maximum Rate of Fire
- Maximum Range
- Minimum Range
- Accuracy Requirement



BAND 1: (7) FCS KPPs

BAND 2: (23) Requirements Underpinning K

BAND 3: (126) Requirements that Underpin

BAND 4: (240) Threshold Requirements

BAND 5: (156) Objective Requirements

- Future Munition Technologies

There Are Requirements In Every Band That Affect NLOS-Cannon. There are 17 Specific NLOS-Cannon Requirements

Summary

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

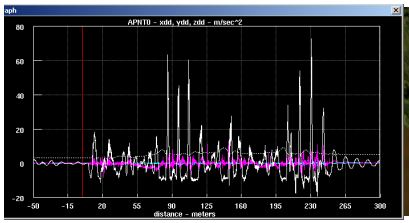
- The NLOS-Cannon is one of the Future Combat System's family of systems.
- NLOS-Cannon has 147 PCD requirements to meet. Seventeen of these are cannon specific.
- The Army has developed a FCS ORD structure placing FCS ORD requirements within a band structure.
- FCS ORD bands facilitate the decision process allocating key requirements decisions to the appropriate level.
- All NLOS-Cannon requirements decisions will be made based on a systems of system approach.

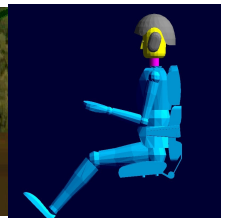
NLOS-C CTD Effort

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

Analysis Conducted

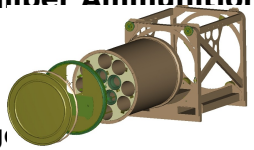
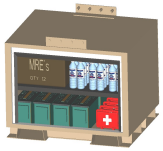
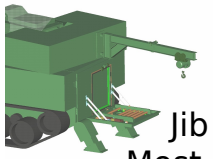
- Recoil System Analysis and Design G-Loads
- Structural Analysis (FEA) System Model
- Vehicle Thermal Transient Analysis (VTT)
- Mobility Vehicle Dynamic (DADS) Analysis
- Crew Gun Fire Shock Tolerance



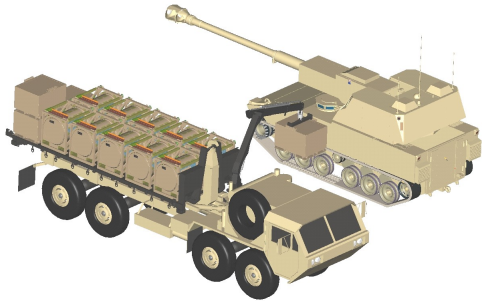


Multi-Role Resupply

- **Large Caliber Ammunition Module**
- **Dry Cargo**

Jib Crane
Most Preferred



Truck Mounted Crane

CTD Insights to Date

- **C-130 weight constraints is the greatest technical challenge, but achievable…with significant trades on survivability and lethality requirements.**
- **Caliber: Both calibers (105mm, 155mm) are viable**
  - **105mm caliber and zone excursions being conducted**
  - **155mm caliber and zone excursions being conducted**
- **Wheels versus Tracks: Both options are viable (Tracks Recommended)**

Stretched Activities

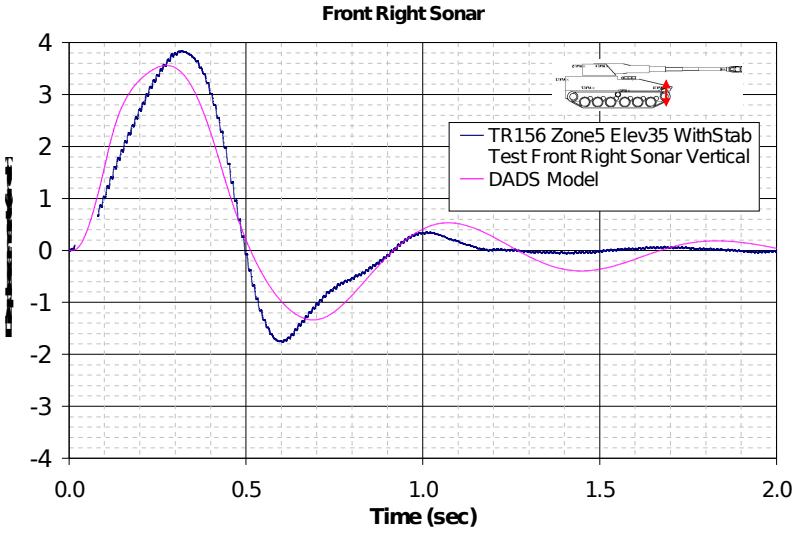
- **Phase 2 System Demonstrator Testing/Firing**
  - **Completed in February 2004**
- **NLOS-C Loader Brassboard**
  - **Start in January (SRR Design)**
  - **Estimated Completion – 30 June 2004**
- **NLOS-C Vertical Propellant Brassboard**
  - **Start in January (SRR Design)**
  - **Estimated Completion – 31 May 2004**

System Demonstrator Accomplishments (Not a Prototype)

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

Activity	Complete
Delivered to YPG	30 July
First Shot 26 Aug	
Stabilized Zone 1&2	Completed
Un-stabilized Zone 1&2	Completed
Limited Zone 2 ROF (6.1 RPM)	Completed
Zone 3	Completed
Stabilized Zone 4&5	Completed
Un-stabilized Zone 1&3	Completed

- Demonstrator Correlation Used To Fine Tune BTA Models
- Demonstrator Being Using To Explore Performance.
  - RoF
  - Vehicle Dynamics
  - G-Loads on Crew Areas
- Discover And Resolve Concept Issues Early.
- Demonstrate New Concepts
  - Propellant Retention Device (PRD)
  - Automated Cannon Cooling System (ACCS)



Summary

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

- **NLOS-C CTD Accomplishments.**
  - **NLOS-C System Demonstrator Completed and in Test**
  - **Multi-role Resupply Concepts Developed**
  - **Detailed Concepts Established (PRO-E Master Models)**
    - **Preliminary Concepts Of Projectile And Propellant Magazines And Shuttles, Gun Mount, Ammunition Loader/Rammer, Lower Mission Module, Turret Shell, Gun Pointing, And Ammo Upload Underway.**
    - **Basic Physical, Electrical And Software Architectures Defined**
    - **Weight And Space (Volume) Allocations And Estimates**
    - **Pit Stop Engineering Models Developed**
  - **Significant Requirement Analysis Conducted**
  - **Established Foundation for NLOS-C and MGV SDD (Prep for SRR and SFR)**

- **SDD Effort Underway.**
  - **Boeing/SAIC - Lead System Integrator**
  - **United Defense Is The Variant Integrator For NLOS-Cannon**
  - **FCS Manned Ground Vehicles (MGV) SRR & SFR Focus**
  - **First Prototype Vehicles In Jun 07**
  - **FCS IOC In 2010 For Increment I (6ea NLOS-C)**

NLOS - Cannon

NLOS Cannon must meet 147 FCS Requirements – 17 of these requirements are unique to the NLOS-C

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

Characteristics:

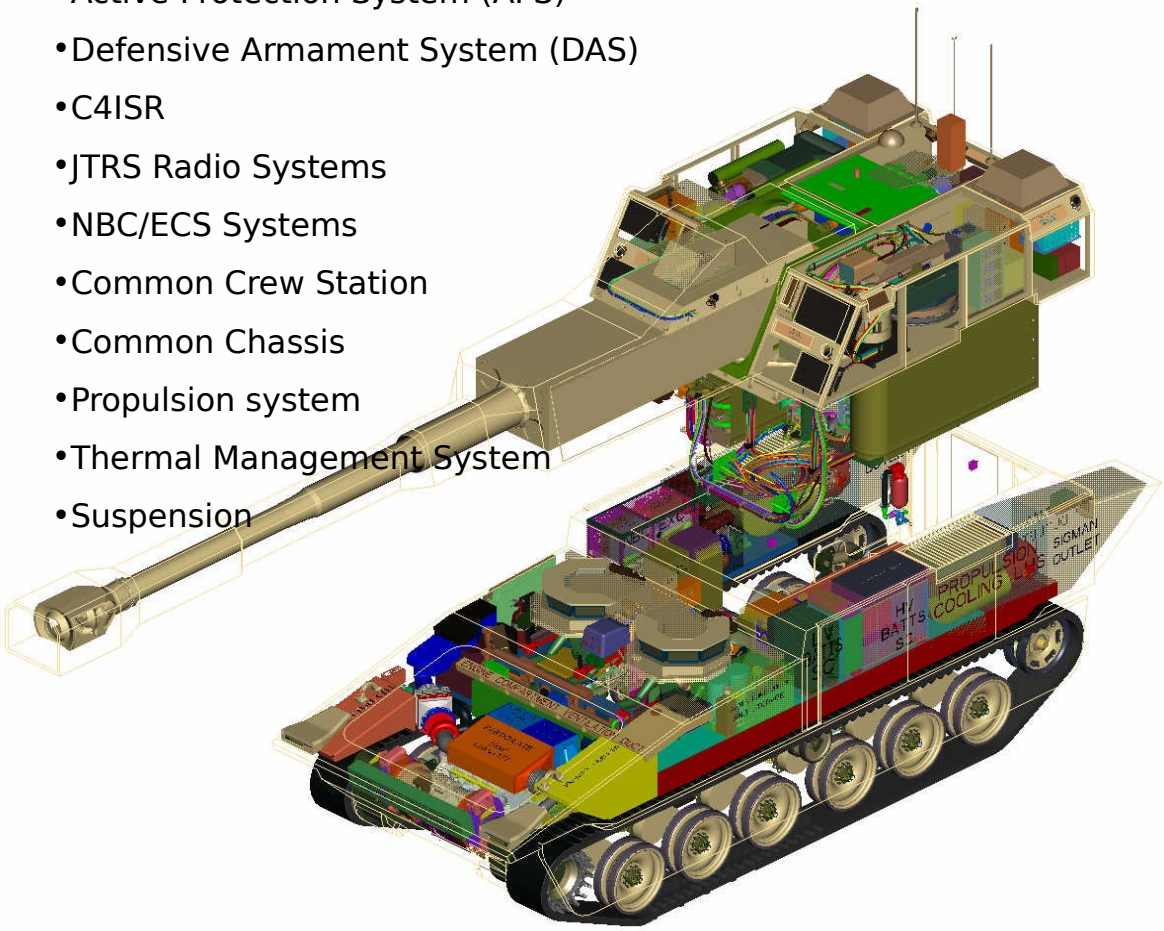
- Fires 30 - 40 km
- Fires 6 - 10 rounds per min
- Responds to fire mission when moving in 20 -30 sec
- Responds to fire mission in 15 - 20 sec when emplaced
- Carries 24 - 48 rounds
- Rearms with crew under armor in 5-12 min

Requirements:

- The FCS FoS must be Joint interoperable
- FCS network must enable Battle Command and provide situational awareness
- Networked lethal and non-lethal effects
- Transportable worldwide by air, sea, highway, and rail
- Achieve significant logistics footprint reduction
- Embedded individual and collective training
- Provide essential protection to mounted and dismounted soldiers

Member of a Family of Systems that Includes:

- Active Protection System (APS)
- Defensive Armament System (DAS)
- C4ISR
- JTRS Radio Systems
- NBC/ECS Systems
- Common Crew Station
- Common Chassis
- Propulsion system
- Thermal Management System
- Suspension



NLOS-Cannon "Top Ten" Design Drivers

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

1. C130 Transport – Establishes Weight And Volume Constraint
2. ECC Weight (Flyweight) Definition – Establishes Required Weight Allocation For Ammo/Fuel (Projectiles On Board Weigh More Than Any Other Component)
3. Survivability – Requires Integral Medium Cannon And Heavy Machine Gun Armor
4. Mine Protection – Drives Armor Design And Interior Volume Availability
5. C4ISR – Drives Overall Vehicle Weight & Internal Volume
6. Reliability – Overall Design And Weight Impacts
7. Silent Watch – Drives Power Capacity And Battery Weight
8. Maximum Range- Drives Cannon Weight And Associated Structure.
9. Maximum and Sustained Rate Of Fire – Drives Structure/Subsystems Weight & Thermal Considerations
10. Automated Rearm Capability - Drives Overall Vehicle Weight & Internal

ECC Weight/C130 Requirements Are "The Eye Of The Needle" For A

MGV Tier 1 and 2 Decisions

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

Air Transportability
- C130 w/ or w/o

Vehicle Configuration

- Design Weight

Mission Equipment Arrangement
- Gun Caliber (MCS, NLOS-C, ICV)
- C4ISR Suite (All Variants)
- Sensor Suite (RSV)
- Ammunition Load
- Infantry Squad Equipment (ICV)

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Crew Arrangement
- Size
- Location
- Configuration

Survivability Suite
- Crew & Passenger Protection*
- Mission Equipment Protection*
- Integral or Add-on
- Active Protection System

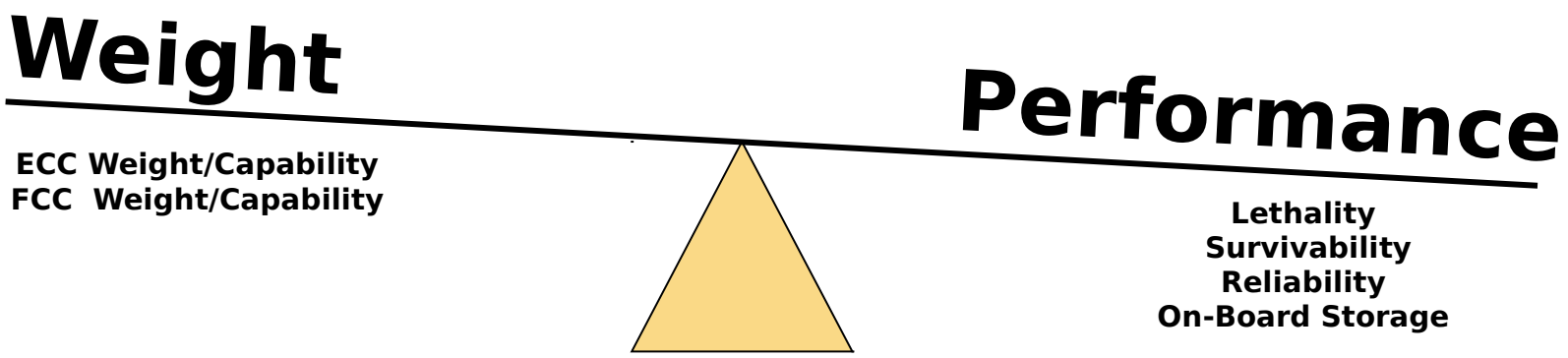
Sustainment Equipment
- MHE for Re-supply & Cross-Leveling
- Water Generation
- On-board Fuel Load
- Days of Rations/Water/Ammo

*Includes Armor / Structure Recipe

NLOS Cannon Caliber Analysis

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

- **Comprehensive Effort Underway to Determine Cannon Caliber**
- **NLOS Cannon Requirements are Demanding – must explore all possible options/combinations**
- **Since C-130 Transportability (i.e. 19 Ton ECC) Is a Firm Requirement, Then Our Exercise Is a Balancing of Weight and Performance – Constrained by Cost and Schedule**



Cannon Caliber Analysis

FUTURE COMBAT SYSTEMS
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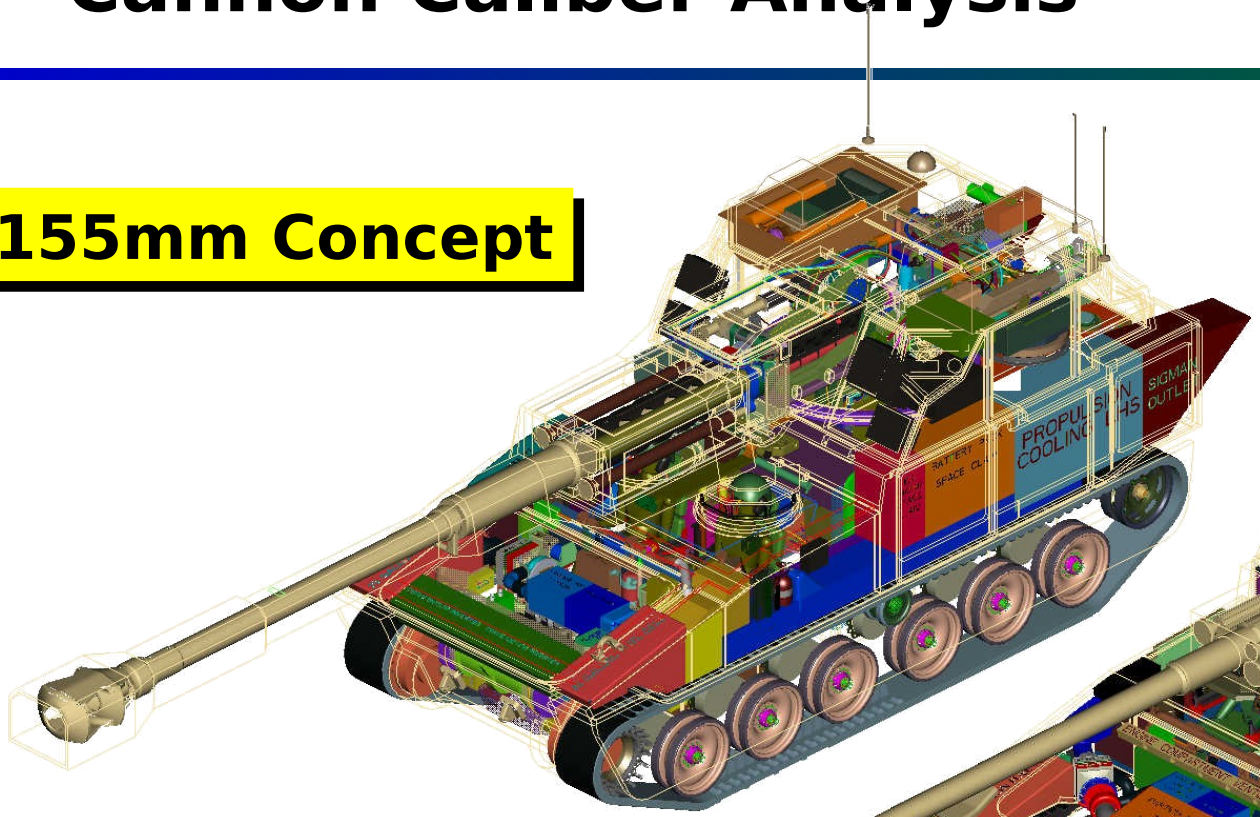
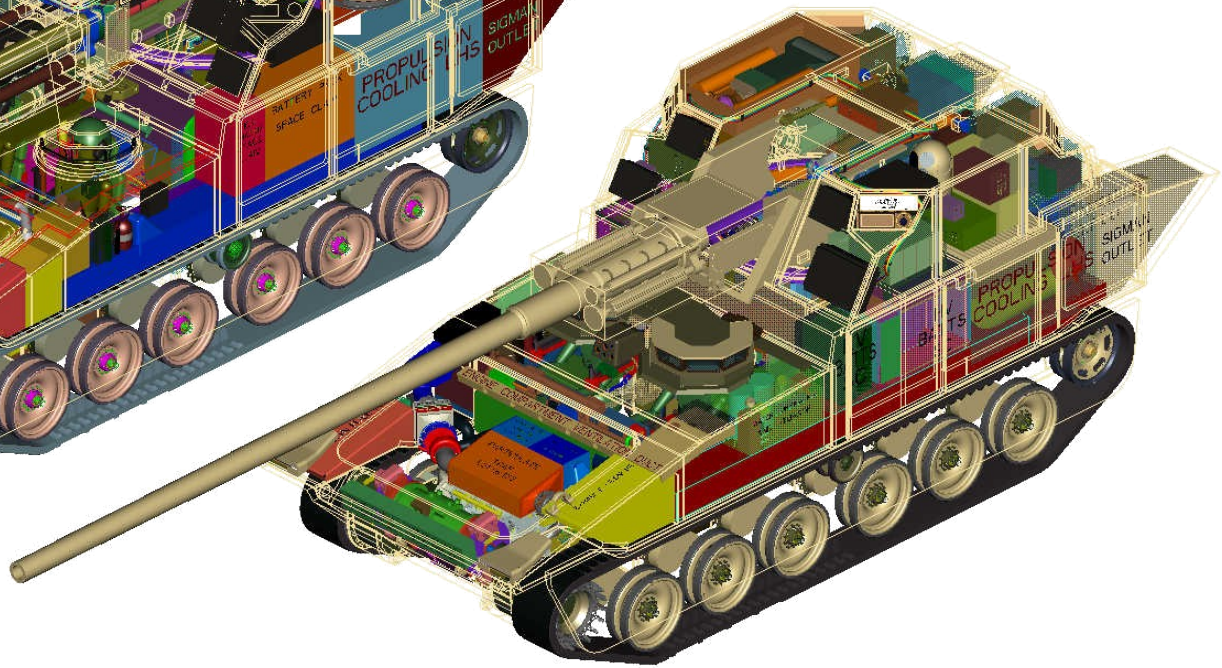
155mm Concept



105mm Concept



- **Comprehensive Analysis (Much larger decision than Cannon**
- **Significant Modeling and Simulation Efforts (UAMBL, Fort Sill**
- **Analysis Includes Lethality, Range, Ammunition, Propellant,**

SRR Efforts – Working 17 Key Criterion

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

1. Requirements Basis
2. Significant System Design Constraints Addressed
3. Key System Trade Studies
4. Operational Scenarios
5. Functional Decomposition
6. Initial System Architecture
7. Draft Life Cycle Process
8. Identify Internal and External Interfaces
9. Technical Risks
10. Technical Performance Measurements
11. System Integration and Verification
12. Supplier Requirements Specification (PCD's)
13. System Technical Processes and Plans
14. Initial System Software Architecture
15. System Performance Model
16. System & Software Safety Plans
17. Initial Cost Allocations Evaluated

BTA Path Forward Process
(Primary Inputs and Key SFR Documentation)

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

Point of Departure (POD)

- POD Allocations & Guidance

Design Concept Review (DCR)

- PCD Exception Resolution Results
- Results of SoS Trades
- SDD-24 Final Trade Study Results

Mid Course Correction

- MGV Tier 2 Trade Study DDMs
- MGV Whole System Trades
- Architectures & ICD Development

SFR End Products

- Major Configurations Trades
  - Approved Tier 1 Decisions
  - Preliminary Tier 2 DDMs
- Requirements Baseline
  - PIDS
  - Singularized / Allocated / Derived
  - Installation Allocations & Estimates (By Installation)
    - Weight RAM Cooling Power
    - Cost Space Claim
  - Design Parameter Document (Design Guidance)
- Installation & Platform Models
- Architectures
- Draft Part 2 ICDs by